(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 152 406 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
07.11.2001 Bulletin 2001/45

(51) Int Cl.[7]: G11B 7/24

(21) Application number: 01109918.1

(22) Date of filing: 24.04.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 24.04.2000 JP 2000123133

(71) Applicant: SONY CORPORATION
Tokyo (JP)

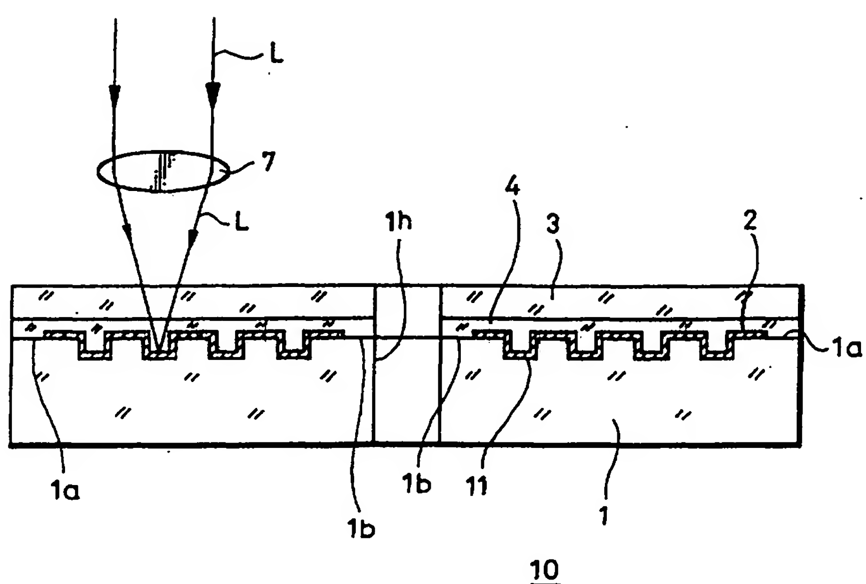
(72) Inventors:
- Yukumoto, Tomomi, Sony Corporation Tokyo (JP)
- Yamasaki, Takeshi, Sony Corporation Tokyo (JP)
- Kashiwagi, Toshiyuki, Sony Corporation Tokyo (JP)

(74) Representative: MÜLLER & HOFFMANN
Patentanwälte
Innere Wiener Strasse 17
81667 München (DE)

(54) **Optical recording medium**

(57) To suppress an occurrence of corrosion in a recording layer composing an optical recording medium (10) and avoiding separation of a light transmission layer (3), a signal region constituted of pits and/or grooves, a recording layer (2) and a light transmission layer are formed on a non-magnetic supporting substrate (1). The recording layer is formed on the entire signal region and it is not formed in other region than the signal region in an outermost peripheral portion (1a) and an innermost peripheral portion (1b) of the non-magnetic substrate.

F I G. 1



EP 1 152 406 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to an optical recording medium.

Description of the Related Art

[0002] Recently, digitization of broadcasting has been accelerated, so that digital high definition (HD) broadcasting is scheduled. It has been generally said that a recording capacity necessary for digital high definition is 11 GB for an hour.

[0003] As a current optical recording medium of compact disc size (hereinafter referred to as CD) having a recording layer of a single-layer structure, a format having a recording capacity of 3.0-5.2 [GB] has been proposed and realized for actual use.

[0004] Optical recording media having basically common optical parameters, or, the same system as those of DVD-ROM (Digital Varsatile Disc-Read Only Memory) but different format depending on groove structure and recording material have been known, for example, GIGA-station, NEC: DVD-R/W, Pioneer: DVD+R/W, Philips: DVD-RAM, PANASONIC and the like.

[0005] However, under the condition of recording capacity of 3.0-5.2 [GB], there has been a problem that picture quality decreases as compared to the current VHS if it is intended to record pictures for two hours at standard picture quality (SD: Standard Definition). Thus, actually, the recording time is restricted to about an hour even to realize the standard picture quality.

[0006] The recording capacity provided by the conventional technology cannot satisfy requirements for achieving the digital HD (high definition) broadcasting.

[0007] To increase the recording capacity of the optical recording medium on the basis of these actual condition, it is effective to reduce the spot size of recording laser to increase the recording speed.

[0008] More specifically, to reduce the spot size of the recording laser, methods for reducing wavelength λ of laser beam and method for increasing a numerical aperture N.A. of an objective lens to concentrate the laser beam to the optical recording medium have been proposed.

[0009] Particularly, by employing both the method for reducing the wavelength λ of the laser beam and the method of increasing a numerical aperture N.A. of the objective lens, the spot size of the laser beam can be made smaller than when either of them is employed individually.

[0010] For example, by using a blue-violet laser beam of near λ = 405 [nm] band in wavelength and employing an objective lens having a numerical aperture of N.A. = 0.85, it is theoretically, possible to achieve higher density recording.

[0011] To raise the recording density in this way, it is necessary to decrease the value of (λ/N.A.).

[0012] As described above, by using a blue-violet laser beam of near λ = 405 [nm] band in wavelength and employing an objective lens having a numerical aperture of N.A. = 0.85, a large recording capacity of $(0.65/0.405) \times (0.85/0.60)^2 = 5.17$ [times] can be achieved as compared to a format having conventional DVD optical parameters, λ = 0.65 [μm] in wavelength and numerical aperture N.A. = 0.60.

[0013] Therefore, following the above described format, a recording capacity of 15.5-26.9 [GB] can be achieved as compared to 3.0-5.2 [GB].

[0014] FIG. 20 shows a schematic structure diagram of an example of a conventional optical recording medium 100.

[0015] Considering a currently available optical recording medium which can apply to red laser beam to blue laser beam, the thickness of the light transmission layer 103 formed in the surface on the side to be irradiated with the laser beam is preferably 3-177 [μm].

[0016] The optical recording medium 100 shown in FIG. 20 includes a non-magnetic supporting substrate 101 made of for example, glass, polycarbonate resin, polyolefine resin or the like having fine unevenness 110 such as predetermined pits and/or groove formed in the surface. On the substrate 101, a recording layer 102 is formed, corresponding to various optical recording mediums, such as that a metal reflection layer made of, for example, Al, Ag or the like, a dielectric layer made of, for example, Si_3N_4 or the like, and a recording material layer made of magnetic substance such as TbFeCo, GdFeCo. A light transmission layer 103 made of, for example, ultraviolet curing resin is formed on the recording layer 102.

[0017] If recording or reproduction of information is to be executed on or from the optical recording medium 100 shown in FIG. 20, a predetermined laser beam **L** is converged with an objective lens 111 and irradiated on a main surface opposite to the side of the non-magnetic supporting substrate 101 or in FIG. 20 on the side of a face in which the light transmission layer 103 is formed.

SUMMARY OF THE INVENTION

[0018] In the format having the DVD parameters, the light transmission layer 103 which covers the signal region face or signal recorded region is set to about 0.6 mm and thus, if a high numerical aperture N.A. (=0.85) is employed for improvement of the recording density, spherical aberration and coma aberration become problem.

[0019] The spherical aberration has a correlation with the thickness of the light transmission layer 103. If the thickness is shifted by Δt with respect to a set value of the thickness of the light transmission layer 103, the spherical aberration increases proportional to the fourth

power of numerical aperture N.A.. Therefore, if the numerical aperture N.A. of the objective lens is 0.85 assuming that the thickness deviation of the light transmission layer 103 of the DVD is ±30 [μm], the spherical aberration has to be limited to ±7.4 [μm] for the reason of the [expression 1] described below.

[Expression 1]

[0020]

$$\pm 30 \times (0.60/0.85)^4 = \pm 7.4\ [\mu\ m]$$

[0021] On the other hand, the coma aberration is proportional to the third power of the numerical aperture N. A.. Therefore, it has to be limited to ±0.14° with respect to the skew standard of the DVD of 0.4° for the reason of [Expression 2] described below.

[Expression 2]

[0022]

$$\pm 0.4 \times (0.60/0.85) = \pm 0.14°$$

[0023] Further, because these aberrations are inversely proportional to the wavelength, if the wavelength of an applied laser beam is for example, λ = 405 [nm], the deviation of thickness has to be limited to ±4.6 [μm] for the reason of [Expression 3] described below.

[Expression 3]

[0024]

$$\pm 7.4\ [\mu m] \times (0.405/0.650) = \pm 4.6\ [\mu m]$$

[0025] Further, the coma aberration has to be limited to ±0.087°for the reason of [Expression 4] described below.

[Expression 4]

[0026]

$$\pm 0.14° \times (0.405/0.650) = \pm 0.087°$$

[0027] On the other hand, the coma aberration can be corrected by reducing the thickness of the light transmission layer 103. For example, by reducing the thickness of the light transmission layer 103 from 0.6 [mm] to 0.1 [mm], sixfold skew margin can be obtained.

[0028] That is, it is permitted to be ±0.522°for the reason of [Expression 5] described below.

[Expression 5]

[0029]

$$\pm 0.087° \times 6 = \pm 0.522°$$

[0030] However, the deviation of the thickness of the light transmission layer 103 has to be limited to ±4.6 [μm] as described above. Particularly, in the optical recording medium capable of both recording and reproducing, a predetermined accuracy is required for both of recording and reproduction. Thus, the deviation of the thickness has to be distributed to these and as a conclusion, the deviation of the thickness has to be limited to ±2.3 [μm] which is half of the above described value.

[0031] In a recording/reproduction system with short wave laser and high numerical aperture N.A., recording and reproduction in the future HD (High Definition) is realized by achieving a light transmission layer of 100 μm in thickness with the deviation of the thickness of ± 2.3 [μm].

[0032] Because, as described above, the signal pits or groove in the recording layer 102 is fine and the thickness of the light transmission layer 103 is very small in the optical recording medium for high density recording, particularly, it is necessary to improve corrosion resistance of the recording layer 102.

[0033] That is, in case of the optical recording medium for high density recording, the recording layer 102 is close to the air in an outermost peripheral portion 100a and an innermost portion 100b of the optical recording medium 100 of FIG. 20. Therefore, corrosion is likely to occur from this portion. For example, if recorded information is reproduced from the optical recording medium 100, this corrosion may induce reproduction failure, so that reliability of the optical recording medium 100 may be badly affected.

[0034] In the optical recording medium shown in FIG. 20, because the recording layer 102 composed of various materials exists between the light transmission layer 103 and the non-magnetic supporting substrate 101 in the outermost peripheral portion 100a and the innermost portion 100b, there is generated a problem that separation occurs from this portion as the thickness of the light transmission layer 103 decreases.

[0035] Accordingly, as a result of accumulated researches by present inventors, there is provided an optical recording medium having a high reliability in which a recording beam or a reproduction beam is irradiated from the side of the light transmission layer, an occurrence of corrosion in the recording layer composing a large-capacity optical recording medium being avoided and separation of the light transmission layer in the outermost peripheral portion 100a and innermost portion 100b of the disc being suppressed.

[0036] The present invention provides optical recording medium characterized in that a signal region consti-

tuted of information pits and/or groove are formed on a main surface of a disc-shaped non-magnetic supporting substrate and a recording layer and a reflection layer and a light transmission layer of 3-177 [µm] in thickness are formed in the signal region, so that information reproduction and/or recording is carried out by irradiating the side of the light transmission layer with laser beam, the recording layer or the reflection layer being formed in the entire signal region but not formed in other region than the signal region in an outermost peripheral portion and an innermost portion of the disc-shaped non-magnetic substrate.

[0037] Because in the optical recording medium of the present invention, the substrate and the light transmission protective layer are made in direct contact with each other in the outermost peripheral portion and the innermost portion, adhesiveness is improved, so that the disc hardness can be improved.

[0038] Further, an occurrence of corrosion in the recording film in the innermost portion and the outermost peripheral portion can be avoided.

BRIEF DESCRIPTION OF THE DRAWINGS

[0039]

FIG. 1 shows a schematic sectional diagram of an example of the optical recording medium of the present invention;
FIG. 2 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 3 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 4 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 5 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 6 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 7 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 8 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 9 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 10 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 11 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 12 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 13 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 14 shows a production process diagram for an example of the optical recording medium of the present invention;
FIG. 15 shows a relation between the error rate and a distance from the center of a disc in the optical recording medium of the present invention;
FIG. 16 shows a relation between the error rate and a distance from the center of a disc in a conventional optical recording medium;
FIG. 17 shows a schematic sectional diagram of other example of the optical recording medium of the present invention;
FIG. 18 shows a schematic sectional diagram of other example of the optical recording medium of the present invention;
FIG. 19 shows a schematic sectional diagram of other example of the optical recording medium of the present invention;
FIG. 20 shows a schematic sectional diagram of other example of the conventional optical recording medium;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0040] The optical recording medium of the present invention is comprised a signal region composed of information pits and/or groove, a recording layer and/or a reflection layer formed by coating this signal region with material corresponding to the kind of a target recording medium and a light transmission layer of 3-177 [µm] in thickness made of ultraviolet-curing resin, these layers being formed on a major surface of a non-magnetic supporting substrate made of for example, polycarbonate. By irradiating the side of the light transmission layer with laser beam, reproduction and/or recording of information are carried out. The recording layer or the reflection layer is formed on an entire signal region on the non-magnetic supporting substrate. No film is formed on region other than the signal region on a outermost peripheral portion and a innermost portion of the disc shaped non-magnetic substrate. In the outermost peripheral portion and innermost portion, no recording layer or reflection layer exits between the light transmission layer and the nonmagnetic supporting substrate.

[0041] Hereinafter, the embodiments of the optical recording medium of the present invention will be described by picking up examples. The optical recording medium of the present invention is not restricted to the examples described below.

[0042] FIG. 1 shows a schematic sectional view of an